M.O. 702

Price 2s. 6d. Net Monthly

THE METEOROLOGICAL MAGAZINE

January 1961

No. 1,062, Vol. 90

CONTENTS

JANUARY 1961

NOTICES

It is requested that all Books for Review and Communications for the Editor be addressed to the Director-General, Meteorological Office, Air Ministry, Headstone Drive, Harrow, Middlesex, and marked "for Meteorological Magazine".

The responsibility for facts and opinions expressed in the signed articles and letters published in this magazine rests with their respective authors.

All inquiries relating to the insertion of advertisements in the Meteorological Magazine should be addressed to the Director of Publications, H.M. Stationery Office, Atlantic House, Holborn Viaduct, London E.C.1. (Telephone: CITy 9876, extn. 147).

© *Crown Copyright 1961*

Printed in England by Geo. Gibbons Ltd. Leicester
and published by
HER MAJESTY'S STATIONERY OFFICE

Price 2s. 6d. **Annual subscription 32s. including postage**

(K15) S.O. Code No. 40-43-61-1

M.O. 702 AIR MINISTRY

METEOROLOGICAL OFFICE

THE METEOROLOGICAL MAGAZINE

VOL. 90, No. 1,062, JANUARY 1961

S. P. PETERS, C.B.E., B.Sc.

Mr. S. P. Peters retired from the Meteorological Office on 31 October 1960 after more than 37 years' service.

His first connexion with official meteorology was in 1918 when he was on active service with the Meteorological Section of the Royal Engineers in Italy, but he did not join the Meteorological Office until 1923, after graduating with first class honours in physics, and working privately with Mr. C. J. P. Cave, a past President of the Royal Meteorological Society.

His initial posting was to Cranwell as Junior Professional Assistant. In 1925 he was promoted to Senior Professional Assistant and appointed to be the first Professional Assistant in the newly created Airships Services Division. For the next seven years he was based at Cardington, and apart from occasional interludes of forecasting for airship trial flights at Pulham and Howden, was occupied in the investigation of meteorological conditions along potential airship routes, and at planned bases within the Commonwealth. Following the disbandment of the Division after the disaster to airship R.101 Mr. Peters served for three years at Worthy Down, one of three R.A.F. stations at which night flying by bomber aircraft was then being developed.

In the summer of 1935 he was appointed instructor to the first training course for forecasters in the Meteorological Office, which was held at South Kensington. Owing to the Abyssinian crisis this course came to a premature and abrupt end after a few months and the six trainees (Assistants II) were posted for forecast duties. Mr. Peters was then transferred to Croydon to inaugurate a training course for new-entrant graduates, in which special attention was to be given to the synoptic meteorology of the North Atlantic, in anticipation of transatlantic civil flying.

In the spring of 1937 he was promoted Senior Technical Officer and posted to Foynes, where for the ensuing four years he was responsible for forecasting for the first, and subsequent, transatlantic commercial flights and for the training of staff for the newly established Irish Meteorological Service. Early in 1941 he was recalled to England for duty as Senior Meteorological Officer at the Overseas Air Movement Control Unit at Gloucester, and a few months later was transferred to Prestwick to establish a forecasting centre for aircraft delivery flights from Canada by R.A.F. Ferry Command and for return flights

of the ferry crews. In the late autumn of 1941 Mr. Peters was promoted Principal Technical Officer and appointed Head of the new North Atlantic Branch at Headquarters, with which was subsequently combined the Coastal Command Branch. In a reorganization shortly after the war he became Head of the newly constituted Civil Aviation Branch.

In March 1948 he was posted to the Central Forecasting Office at Dunstable with promotion to Senior Principal Scientific Officer, and shared supervisory forecasting duties with two colleagues for the next five years. In June 1953 he became Deputy Director (Forecasting) in the grade of Deputy Chief Scientific Officer and remained in this post, when it was later renamed "(Central Services)" until his retirement in July 1958 on grounds of age. Since his retirement Mr. Peters has occupied a Senior Scientific Officer post in the Techniques and Training Branch at Meteorological Office Headquarters.

Mr. Peters was a member of the Commission for Synoptic Weather Information of the International Meteorological Organization and, subsequently, of the Commission for Synoptic Meteorology of the World Meteorological Organization and also of Regional Commission VI (Europe). In these capacities he has represented the Meteorological Office at conferences in Paris, Salisbury (S. Rhodesia), Washington and Dubrovnik. Whilst Head of the Civil Aviation Branch he was a delegate at meetings of the International Civil Aviation Organization in Dublin and Paris in 1946. Mr. Peters was made a Companion of the Order of the British Empire in 1956.

His success as a pioneer over the years in a great many fields of an expanding meteorological service was due not only to his knowledge of meteorology and powers of organization but also to his personal interest in the well-being of his staff and his human understanding of their problems. All those who have experienced his friendliness and his constant readiness to give unstinting assistance in any difficulty, be it professional or personal, will wish Mr. Peters a long and happy retirement.

W. H. BIGG, O.B.E., B.Sc.

Mr. Bigg retired on 21 November 1960 after more than 40 years' service in the Meteorological Office.

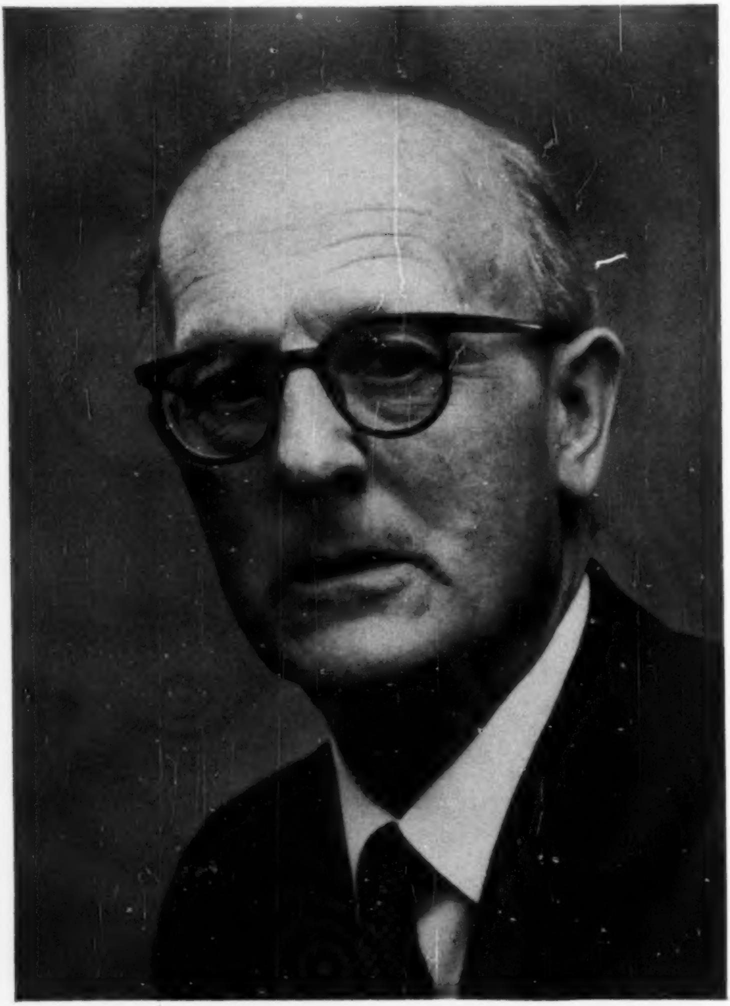
His first appointment, in the grade of Technical Assistant, was in July 1920 and for the next six years he served at the R.A.F. Station, Biggin Hill. During this period Mr. Bigg studied in his spare time and passed the B.Sc. (General) degree of London University in 1924 and after a further two years he obtained an honours degree in physics in the examination for B.Sc. (Special). As a result of these academic successes Mr. Bigg was promoted to Professional Assistant, the forerunner of the Scientific Officer Grade, and took up forecasting duties first at Headquarters and later at the Royal Aircraft Establishment, Farnborough, followed in 1934 by a posting to the R.A.F. Station at Bircham Newton and in 1937 by a return to Headquarters. During this period he made a special study of ice formation in clouds and published the results as a *Professional Note* which achieved wide circulation among aviators and meteorologists.

During the inter-war years Mr. Bigg was an active member of the Reserve of Air Force Officers and on the outbreak of the Second World War he was

[To face p. 2

S. P. PETERS, C.B.E., B.SC.

To face p. 3]



W. H. BIGG, O.B.E., B.SC.

mobilized and, as a Squadron Leader, was appointed Senior Meteorological Officer to the Advanced Air Striking Force. His unit was the first meteorological section to arrive in France in September 1939. During the operations which led to the withdrawal of British Forces from France, Sqn. Ldr. Bigg received a mention in despatches. He then joined No. 1 (Bomber) Group, R.A.F. where he served with such distinction that he was appointed an Officer in the Military Division of the Order of the British Empire.

In 1943 plans were being developed for a more vigorous prosecution of the war in the Far Eastern Theatre and Sqn. Ldr. Bigg was promoted to Group Captain on appointment as Chief Meteorological Officer, Air Command, South-East Asia. This appointment carried enormous responsibilities both in planning and directing a wartime meteorological organization and in preparing the framework for a revived territorial organization in peace.

When the war ended Group Captain Bigg returned to Headquarters in London and in the 1948 re-organization he became an Assistant Director with responsibility for meteorological services required by Civil Aviation. In this post he has seen, and made important contributions to, the remarkable growth of airline operations with their splendid record of safety, regularity and punctuality.

During 40 years in meteorology, Mr. Bigg has not only seen an enormous number of changes and developments but has been actively associated with many of them. As a forecaster he was always in the first rank and enjoyed a high reputation among pilots. Meteorological organization, with its comprehensive array of technical procedures and regulations, owes much to him and many will acknowledge his wise counsel at international meetings. However, it is not enough merely to say that this has been a career full of performance. Hosts of people, service and civilian, of many nationalities, can testify to "Bertie" Bigg's capacity for friendship, to his wise and tolerant leadership, to his good humour and patience in protracted discussions. We wish him, with his wife and family, many years of happy retirement.

551. 507. 352: 551. 521. 14:
551. 524. 7: 551. 557. 3: 551. 576. 1

HIGH-ALTITUDE OBSERVATIONS BETWEEN THE UNITED KINGDOM AND NAIROBI

By M. J. KERLEY

Introduction.—In June 1958 a Canberra aircraft, of the Meteorological Research Flight, was detached from Farnborough to Eastleigh Airport, Nairobi (latitude 1°S). It left Farnborough on 19 June 1958 and arrived at Nairobi on 21 June, having flown by way of Malta, Cyprus, Bahrain and Aden. Twelve flights were made from Eastleigh Airport between 22 June and 29 June. The aircraft left Nairobi on 2 July and, travelling over the same route, arrived back at Farnborough on 4 July.

The purpose of the detachment was to obtain measurements up to about 50,000 feet of temperature, humidity, wind and albedo and also cloud and clear-air turbulence information in low latitudes over Africa. Several of these quantities have not previously been measured. It is intended to combine them in later papers with other Meteorological Research Flight observations made in high latitudes but, in view of their general interest, the results obtained in this series of flights, and also during the transit flights, are presented below.

Instrumentation.—The instrumentation of this aircraft has been described in some detail elsewhere.[1] Briefly, temperature is measured by means of a flat-plate resistance thermometer and balanced bridge; humidity is observed with the manual Dobson–Brewer frost-point hygrometer; wind is obtained from the Doppler navigator; albedo in the wavelength range $0 \cdot 3$ to $3 \cdot 0\ \mu$, which covers all but the weak, extreme long-wave portion of the solar spectrum, is calculated from solarimeters mounted on the upper and lower fuselage; an accelerometer is switched on when turbulence is encountered; readings and cloud notes are taken by the observer approximately every five minutes and photographic recordings are obtained on automatic observers each minute of the flight.

Flight details.—In all 23 flights were made, 11 in transit and 12 at Nairobi and these are summarized in Table I below. Most of them were successful although there were some limitations due to failure of the wing-tip tanks to feed above 30,000 feet after leaving Malta, liquid nitrogen supplies for the frost-point hygrometer being available only at Nairobi, and partial failure of the canopy demisting equipment which sometimes made cloud observation at altitude difficult and cloud photography impossible. The Doppler navigator failed to operate over the smooth sea of the Persian Gulf on the return flight.

TABLE I—FLIGHT DETAILS

Date	Flight No.	Route	Time GMT	Flight Level ft $\times 10^{-3}$	Observations taken
16.6.58	1	Farnborough–Malta	0835–1115	38.0	Frost point, temp., albedo, winds
17.6.58	2	Malta–Cyprus	0555–0805	42.0	Temp., winds, albedo
17.6.58	3	Cyprus–Bahrain	1000–1320	33.5, 44.0	Temp., winds, albedo
18.6.58	4	Bahrain–Aden	0240–0550	31.5, 38.0	Temp., winds, albedo
18.6.58	5	Aden–Nairobi	0735–1005	32.0	Temp., winds, albedo
19.6.58	6	High-level ascent from Nairobi	0605–0745	climb to 50.0	Frost point, temp., winds, albedo
19.6.58	7	High-level ascent from Nairobi	0900–1045	climb to 50.0	Frost point, temp., winds, albedo
20.6.58	8	Nairobi–Aden	0550–0900	30.0, 46.0	Frost point, temp., winds, albedo
20.6.58	9	Aden–Nairobi	1020–1250	30.0, 46.0	Frost point, temp., winds, albedo
23.6.58	10	Nairobi–9°S–Nairobi	0635–1000	30.0, 46.0	Frost point, temp., winds, albedo
24.6.58	11	Nairobi–Aden	0540–0900	30.0, 38.0	Frost point, temp., winds, albedo
24.6.58	12	Aden–Nairobi	1025–1250	30.0, 38.0	Frost point, temp., winds, albedo
25.6.58	13	Nairobi–Aden	0540–0830	30.0, 46.0	Frost point, temp., winds, albedo
25.6.58	14	Aden–Nairobi	1135–1405	30.0, 34.0	Frost point, temp., winds, albedo
26.6.58	15	Nairobi–9°S–Nairobi	0530–0845	30.0, 38.0, 46.0	Frost point, temp., winds, albedo
27.6.58	16	Nairobi–Aden	0540–0840	30.0, 46.0	Frost point, temp., winds, albedo
27.6.58	17	Aden–Nairobi	1010–1245	30.0, 42.0	Frost point, temp., winds, albedo
2.7.58	18	Nairobi–Aden	0550–0825	30.0, 40.0	Frost point, temp., winds, albedo
2.7.58	19	Aden–Bahrain	1005–1320	30.0, 40.0, 48.0	Frost point, temp., wind, albedo
3.7.58	20	Bahrain–Habbaniya	0225–0350	22.5	Temp. only
3.7.58	21	Habbaniya–Cyprus	0655–0900	30.0, 38.0	Wind, temp., albedo
3.7.58	22	Cyprus–Malta	1050–1310	30.0	Temp., albedo
4.7.58	23	Malta–Farnborough	0830–1120	28.5, 36.5	Wind, temp., albedo

The measurements obtained can be divided broadly into the following groups:

(i) Measurements in transit flights.

(ii) Studies of upper air conditions above Nairobi and Aden by vertical soundings. One sounding was also made at Bahrain.

(iii) Horizontal flights between Nairobi and Aden and also to 9°S.

In all cases comparisons are made with available radio-sonde measurements and synoptic charts.

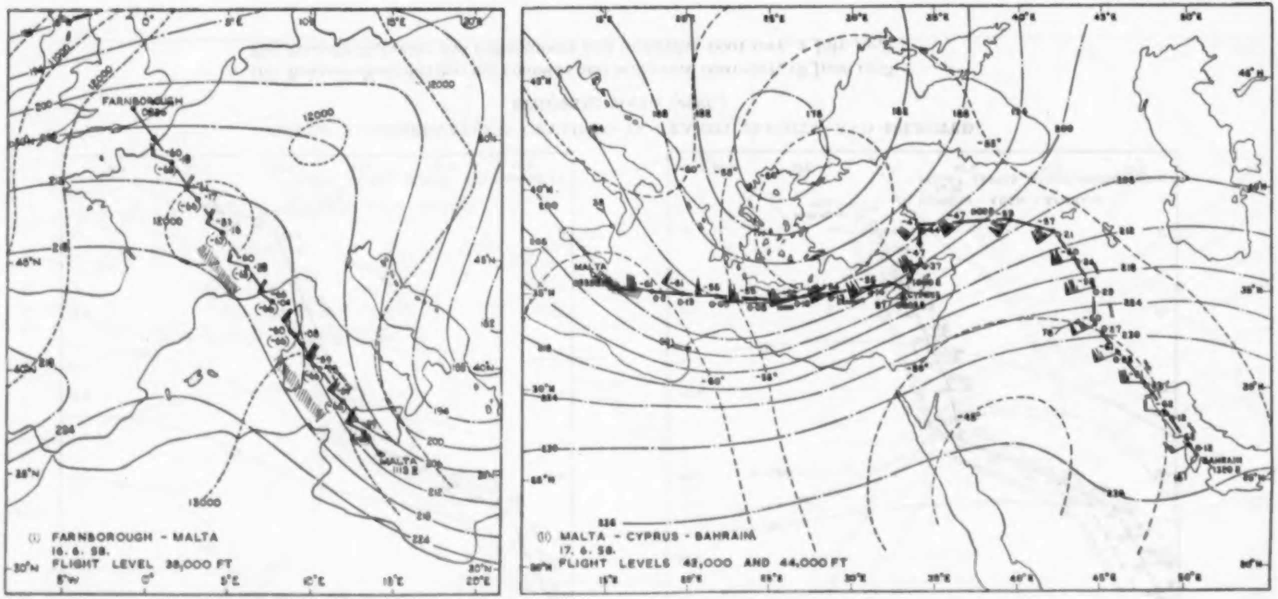
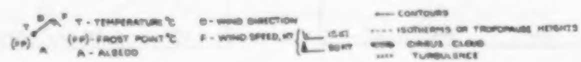


FIGURE 1—OBSERVATIONS OBTAINED IN TRANSIT FLIGHTS, AND SELECTED SYNOPTIC DATA

(i) Farnborough–Malta; 200 mb contours and tropopause, 0001 GMT, 16 June 1958

(ii) Malta–Bahrain; 200 mb contours and isotherms, 0001 GMT, 17 June 1958



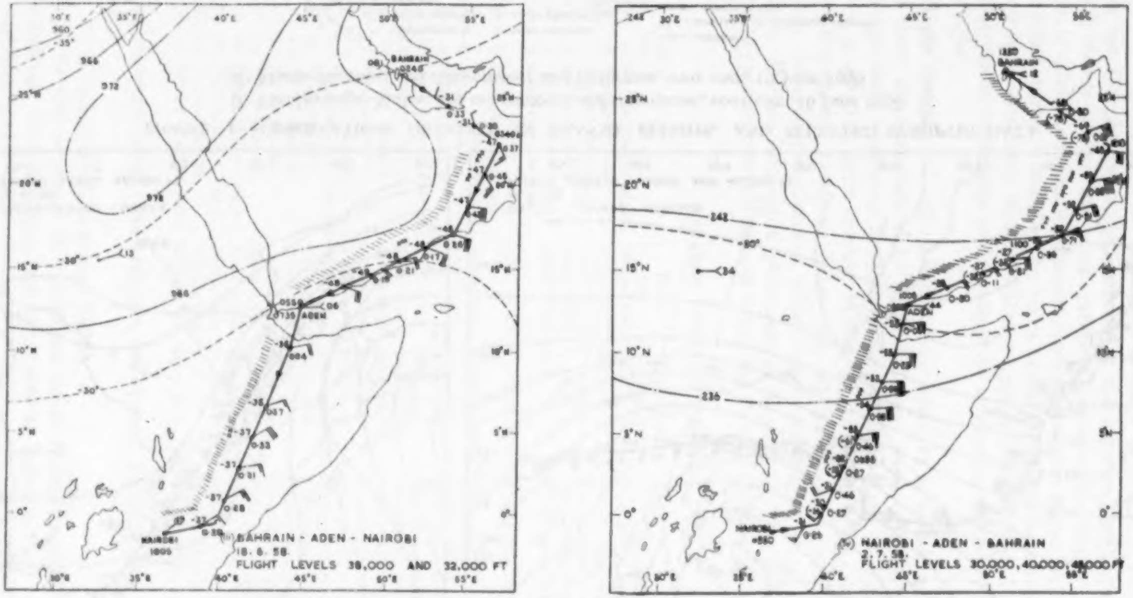


FIGURE 1—OBSERVATIONS OBTAINED IN TRANSIT FLIGHTS, AND SELECTED SYNOPTIC DATA (*cont.*)

(iii) Bahrain–Nairobi; 300 mb contours and isotherms, 0001 GMT, 18 June 1958
(iv) Nairobi–Bahrain; 200 mb contours and isotherms, 0001 GMT, 2 July 1958

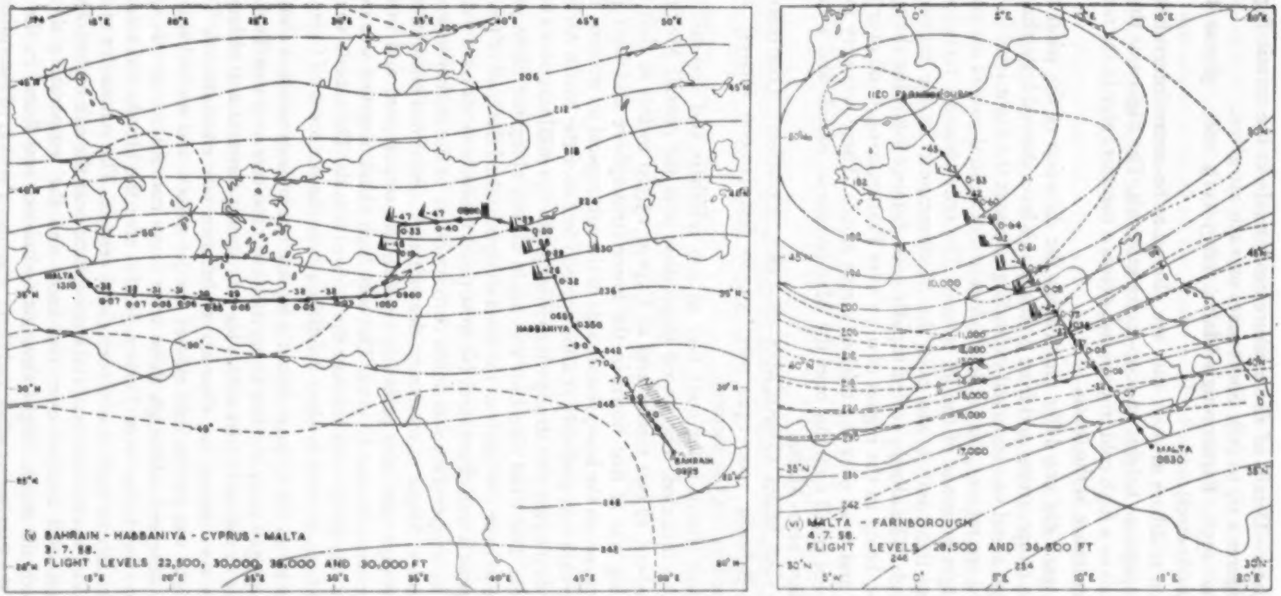


FIGURE 1—OBSERVATIONS OBTAINED IN TRANSIT FLIGHTS, AND SELECTED SYNOPTIC DATA (*cont.*)

(v) Bahrain–Malta; 200 mb contours and isotherms, 0001 GMT, 3 July 1958
(vi) Malta–Farnborough; 200 mb contours and tropopause, 0001 GMT, 4 July 1958

Transit flights.—Details of the measurements made in the transit flights are shown in Figures 1 (i) to (vi). Short notes on each are given.

(i) 16 June 1958, Farnborough–Malta, 0835–1115 GMT, 38,000 feet (11,500 metres).

Contours for 200 millibars at 0001 GMT are plotted at 60-metre intervals and approximate tropopause heights at 1000-metre intervals. The flight was therefore made just below a high cold tropopause, across a contour ridge in the north to a jet-stream entrance in the south.

The aircraft track did not differ much from the direction of the wind trajectories and the temperatures and frost points at this level showed little change throughout. High cloud was observed extending to about the flight level in the central and southern regions, that is, in the forward or central part of the ridge and near the right entrance of the jet stream. The only clear-air turbulence encountered was light and it was over the Mediterranean in the region of accelerating winds. The albedo varied rapidly with distance following the type of surface below, being in the region of 0·17 over France, 0·04–0·08 over the Mediterranean and 0·28 over the thickest cirrus clouds. There was very little other cloud except small cumulus over the Mediterranean islands and a haze top at 16,000 feet near Malta.

(ii) 17 June 1958, Malta–Cyprus, 0555–0805 GMT, 42,000 feet (13,000 metres) Cyprus–Bahrain 1000–1320 GMT, 33,500 feet (10,000 metres) and 44,000 feet (13,500 metres).

The contour chart shown is for 0001 GMT at 200 millibars and 200-millibar isotherms are also included. The lowest tropopause over the central Mediterranean was at about 12,000 metres and at Cyprus 13,500 metres so that the Malta–Cyprus leg was at first flown in the lower stratosphere and later just below the tropopause on the low-pressure side of the subtropical jet stream. The axis of this jet stream was probably at about 30,000 feet over the North African coast but higher to the east with strong winds from 400 to 150 millibars over a very considerable area. The wind direction was again almost along the flight path and the increase to over 100 knots as the aircraft approached the core of the jet stream near Cyprus is well illustrated. No frost-point measurements were made, but an increase in temperature was noted corresponding to the isotherms south of the trough centre. Slight to moderate clear-air turbulence was encountered both near the trough (and also probably crossing the tropopause) and in the region of strongest winds near Cyprus. The only high cloud observed was near Malta and there was small cumulus over the various islands. The albedo varied from 0·2 near Malta to 0·08 in clear conditions over the sea south of Crete.

The observations on the Cyprus–Bahrain leg are not homogeneous, a change of altitude from 33,500 to 44,000 feet being made at 1100 GMT over east Turkey. The temperature in the early part of this leg was almost constant and although the winds were very strong no clear-air turbulence was encountered. This region of the flight was on the cold side of the jet stream and no widespread high cloud was observed, although there were large cumuliform clouds with tops up to 30,000 feet below over Turkey. In this area the albedo was usually about 0·4 but locally as high as 0·6 over cloud centres. The remainder of the flight at 44,000 feet was in the equatorial troposphere near the exit region of the jet stream. Winds still reached over 100 knots and the temperature slowly decreased towards the south. Slight clear-air turbulence was found in the jet stream south of the maximum wind and there was also a region of intermittent

turbulence, sometimes moderate, at the north of the Persian Gulf. Over the whole of this leg the sky was clear apart from small amounts of cumulus in the extreme north. The albedo varied between 0·2 and 0·3 over the desert regions and was about 0·12 along the shores of the Persian Gulf. There was a haze top at 16,000 feet over Bahrain.

(iii) 18 June 1958, Bahrain–Aden, 0240–0550 GMT, 31,500 feet (10,000 metres) and 38,000 feet (11,500 metres)
Aden–Nairobi, 0735–1005 GMT, 32,000 feet (10,000 metres).

The 300-millibar contour chart for 0001 GMT is shown together with the 300-millibar isotherms. It was generally found possible in this work to construct both 300- and 200-millibar charts reasonably to about 15°N but attempts to do this nearer the equator were unsatisfactory. All this leg was of course in the equatorial troposphere. The flight at 31,500 feet over the Persian Gulf showed only light winds, uniform temperature, no cloud and no turbulence. The albedo over land was rather high at 0·3 to 0·33 and there was a rather thick haze up to 16,000 feet.

From 0340 GMT onwards the flight level was 38,000 feet. The wind became rather strong easterly south of 20°N and it appears from other observations of this detachment that this easterly régime continued to well south of the equator. High cloud with its base about 38,000 feet became rather general in this easterly airstream. There was also occasional slight to moderate turbulence just below and in this cloud. The temperature became slightly lower to the south. Stratocumulus was also observed over the extreme south-eastern parts of Arabia where the albedo was between 0·4 and 0·5. Along the south coast of Arabia it was usually in the region of 0·2. The haze top at Aden was at 19,000 feet.

On the Aden-to-Nairobi section the temperature at 32,000 feet was relatively constant throughout and the winds although varying irregularly in speed were all light to moderate easterly. There was widespread high cloud with variable base mainly between 30,000 and 35,000 feet, and one patch of slight clear-air turbulence below the base of this cloud. Lower clouds, mainly stratocumulus and altocumulus, were observed over most of this area and the albedo varied irregularly between 0·2 and 0·4.

(iv) 2 July 1958, Nairobi–Aden, 0550–0825 GMT, 30,000 feet (9,000 metres) and 40,000 feet (12,000 metres)
Aden–Bahrain, 1005–1320 GMT, 30,000 feet (9,000 metres), 40,000 feet (12,000 metres) and 48,000 feet (14,500 metres).

The 200-millibar contour chart and isotherms for 0001 GMT are shown, the gradients being very small. The leg from Nairobi to 0655 GMT was at 30,000 feet where the winds were light to moderate westerly. From there to Aden the flight level was at 40,000 feet where the winds were strong easterly. Occasional moderate clear-air turbulence was encountered during the climb from 30,000 to 40,000 feet which was in a region of strong vertical wind-shear; it was also found intermittently in the stronger easterly wind region at 40,000 feet. Temperatures at each level slowly increased to the north. Considerable high cloud apparently not connected with any cumulonimbus activity was observed all along this route; its base was probably around 40,000 feet in the south and there were small amounts around 35,000 feet with thin layers at 46,000 feet towards Aden. There was also almost complete coverage of stratocumulus

cloud below over the south of the route, decreasing to no low cloud in the north. The albedo varied considerably between 0·2 and 0·6 over land and cloud, and 0·06 over the sea. The haze top at Aden was at 18,000 feet.

The leg from Aden to 1100 GMT was flown at 30,000 feet where the winds were moderate easterly. Between 1100 GMT and 1210 GMT the flight level was 40,000 feet in stronger easterly winds and thereafter 48,000 feet where the wind was strong easterly over south-east Arabia and decreased steadily towards Bahrain. There was no clear-air turbulence at 30,000 or 48,000 feet but it was moderate intermittently all along the portion at 40,000 feet where the aircraft was mainly in the base of high cloud. Considerable amounts of this cloud were observed all along the route with its main base at 40,000 feet and occasional layers below. Over south-east Arabia the aircraft was still in the high cloud at 48,000 feet; near Bahrain there was no high cloud below the aircraft but a thin layer above with base 50,000 feet or more. There was no lower cloud over southern Arabia but to the south-east there was an eight-eighths layer of altocumulus, and towards Bahrain there was again no low or medium cloud. This cloud distribution is reflected in the albedo readings which are about 0·6 to 0·8 in the south-east and 0·1 to 0·2 in the south. On each horizontal leg the temperature steadily increased as the aircraft flew northwards.

(v) 3 July 1958, Bahrain–Habbaniya, 0225–0350 GMT, 22,500 feet (7,000 metres)
Habbaniya–Cyprus, 0655–0900 GMT, 30,000 feet (9,000 metres) and 38,000 feet (11, 500 metres)
Cyprus–Malta, 1050–1310 GMT, 30,000 feet (9,000 metres).

The 200-millibar contour chart and isotherms for 0001 GMT show that, although this portion of the flight returned through a strong westerly wind zone, there was no well marked subtropical jet stream as was encountered on the outward flight. There were instrumental and aircraft faults on the Bahrain–Habbaniya leg and the observations were therefore very limited. High cloud occurred over the Persian Gulf but was not evident in the westerlies to the north. There was no low or medium cloud over this area but a thick dust haze extended to about 18,000 feet. Moderate clear-air turbulence between 13,000 and 19,000 feet was encountered on the climb out of Bahrain.

The flight from Bahrain till 0800 GMT was at 30,000 feet and from then onwards it was at 38,000 feet. At both of these levels moderate to strong westerly winds were measured but there was no clear-air turbulence. At 30,000 feet temperatures were somewhat lower to the north. There was no high cloud throughout, and the only low cloud was cumulus and stratocumulus over the mountains of Turkey. The albedo here was 0·3 to 0·4 compared to 0·2 to 0·3 over Iraq. The haze top over Cyprus was at 10,000 feet.

From Cyprus to Malta the flight was at 30,000 feet almost directly upwind. Temperature was almost constant throughout but it was not possible to measure the winds due to an instrument fault. No clear-air turbulence was found and the only cloud was small amounts of cumulus over Cyprus and Crete. The albedo remained low between 0·05 and 0·07 over the sea throughout. There was a fairly thick haze at Malta from about 16,000 to 5,000 feet.

(vi) 4 July 1958, Malta–Farnborough, 0830–1120 GMT, 28,500 feet (8,500 metres) and 36,500 feet (11,000 metres).

The 200-millibar contour chart and tropopause heights for 0001 GMT are shown. The aircraft was at 28,500 feet until 0935 GMT over Corsica and then

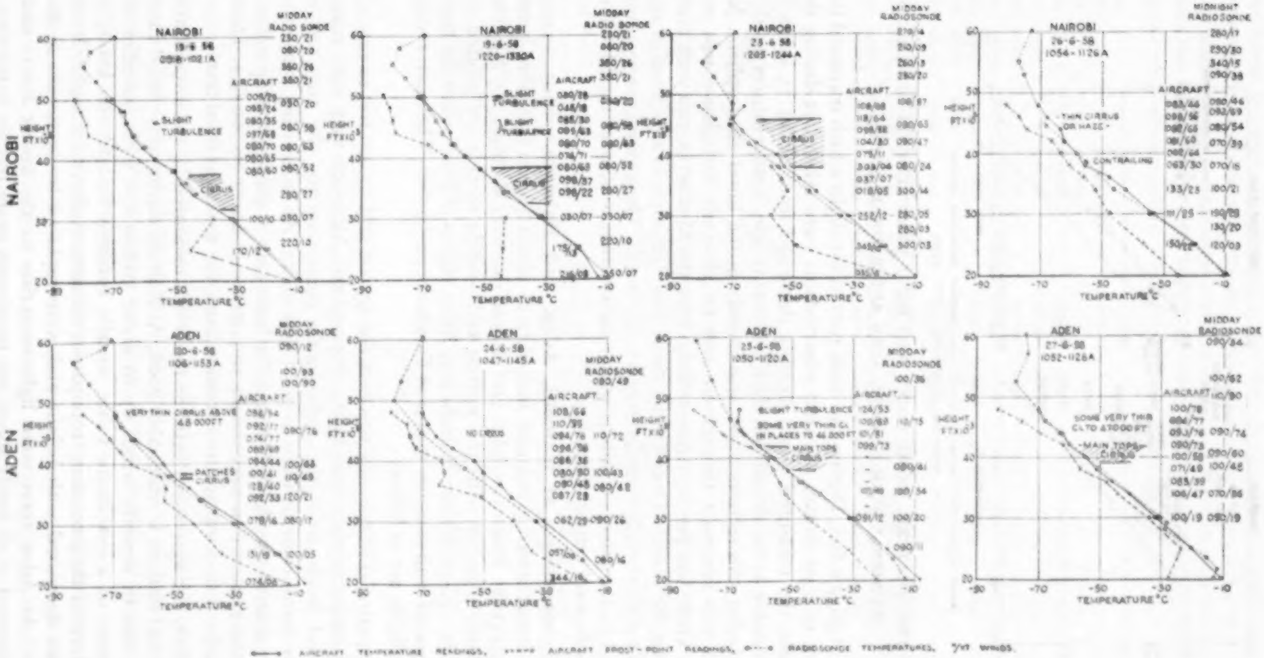


FIGURE 2—TEMPERATURE, FROST POINT AND WIND MEASUREMENTS IN VERTICAL SOUNDINGS OVER NAIROBI, ADEN AND BAHRAIN

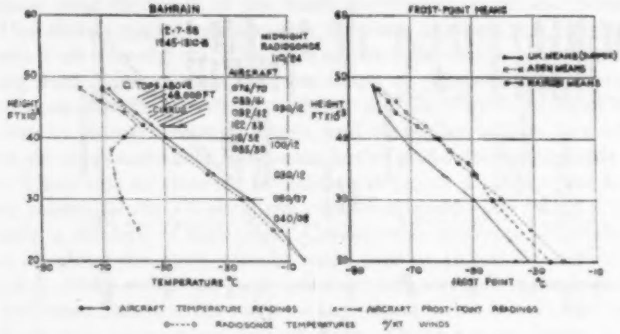


FIGURE 2—TEMPERATURE, FROST POINT AND WIND MEASUREMENTS IN VERTICAL SOUNDINGS OVER NAIROBI, ADEN AND BAHRAIN (*cont.*)

continued at 36,500 feet. During the early part of the flight which traversed the central area of a jet stream no wind observations were taken but during the latter portion the measured winds steadily decreased from about 75 knots to light and variable as the aircraft left the low-pressure side. Temperatures steadily increased during this section which was mainly in the lower stratosphere. No high cloud was observed throughout and no clear-air turbulence was encountered. There was patchy stratocumulus over the Mediterranean with small cumulus over the islands. Over France there was eight-eighths altocumulus and cumulus in the south with cumulonimbus in the north. These cloud observations are reflected in the albedo readings which varied from 0·06 over the Mediterranean to 0·64 over central France.

Vertical soundings at Nairobi, Aden and Bahrain.—Four ascents measuring temperature, wind and humidity to about 48,000 feet were made over Nairobi (1°S), four over Aden (12°N) and one over Bahrain (25°N). The results of these together with the nearest radio-sonde ascents are plotted on Figure 2. Also shown are the Nairobi and Aden means of frost points for these flights compared with summer means at Farnborough (50°N). The main results from these flights are as follows:

(i) The equatorial tropopause was between 55,000 and 57,000 feet so that all the aircraft measurements were in the troposphere. Although they were made up to several hours from the radio-sonde measurements, the two sets of temperature measurements were in good agreement. An interesting feature of many of the ascents was the decrease of the lapse rate in the upper troposphere suggesting the existence of a secondary tropopause at about 46,000 feet. There appeared to be little temperature variation from day to day at fixed levels.

(ii) Similarly the agreement between the winds measured by the aircraft and the radar-wind stations is reasonably good. At Nairobi during this period there were light mainly westerly winds up to about 30,000 feet with easterlies increasing above to a maximum value, usually between 60 and 100 knots, at about the level of the secondary tropopauses mentioned above. At higher levels the easterlies decreased with height and were replaced by westerlies in the stratosphere. At Aden there were light westerlies in the lowest layers with easterlies observed at all levels above, the maximum again usually being 60 to

100 knots between 45,000 and 50,000 feet. It should be noted that there are, however, considerable day-to-day variations in the wind field in these regions and Figure 3 shows time cross-sections of wind at Nairobi and Aden, illustrating how the height range and speeds of the easterly wind belt in the middle and upper troposphere varied throughout this period.

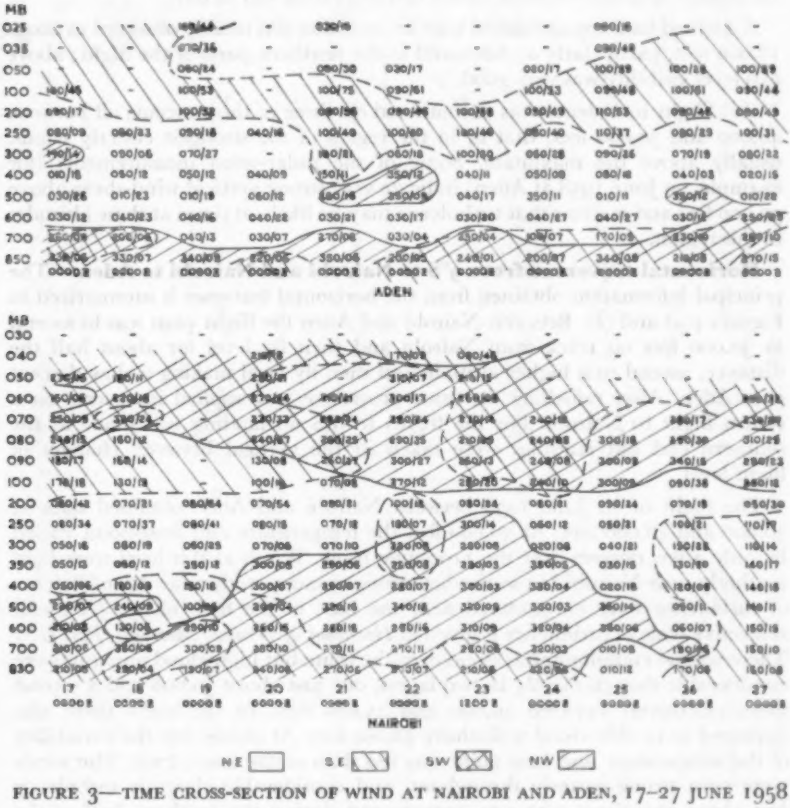


FIGURE 3—TIME CROSS-SECTION OF WIND AT NAIROBI AND ADEN, 17–27 JUNE 1958

Westerly wind areas are shaded.

(iii) The humidity measurements suggest that in the summer the mean frost points over Nairobi and Aden between 20,000 and 40,000 feet are roughly equal and about 12°–15°C greater than over the United Kingdom. Above 40,000 feet, however, this difference decreases with height and at about 50,000 feet the frost point is approximately −80°C at all three locations. The single Bahrain measurement is considerably drier in the middle troposphere but rather moister at 50,000 feet.

Except at Bahrain, where the cirrus tops exceeded 48,000 feet, the aircraft nearly always succeeded in ascending above the main cirrus layer which usually had a base between 30,000 and 40,000 feet and tops in the region of the slackening of the lapse rate near 46,000 feet. Above 46,000 feet the atmosphere became

dry with frost points decreasing to about $-80°C$ near 50,000 feet, a temperature approximating to the tropopause temperature at 55,000 to 57,000 feet. On one occasion (20 June 1958 at Aden), however, some very thin haze or cirrus cloud was seen well above the aircraft's ceiling and was suspected on other flights. There was considerable day-to-day variability in high cloud; and humidity in the middle troposphere often varied markedly from day to day.

A marked haze top associated with an inversion was usually observed at about 18,000 feet, particularly at Aden and in the northern parts of the flight; above this level visibility was very good.

(iv) Slight turbulence was encountered on three of these ascents all between 46,000 and 50,000 feet, that is, in the region of the strongest easterly winds, usually above the maximum. Some of the radar-wind measurements (for example, 20 June 1958 at Aden) indicate very strong vertical wind-shear above 50,000 feet and it seems that turbulence may be likely at times at these altitudes in this region.

Horizontal traverses from 9°S to Nairobi and Nairobi to Aden.—The principal information obtained from the horizontal traverses is summarized in Figures 4(*a*) and (*b*). Between Nairobi and Aden the flight plan was to ascend to 30,000 feet on track from Nairobi and then fly level for about half the distance, ascend to a higher altitude and then fly level making a slow descent over Aden. After refuelling the same procedure was applied in reverse on a return flight to Nairobi. For the flights to 9°S no landing was made at the southern end but readings were taken in the vertical between changes of flight level.

The flight of 20 June 1958 between Nairobi and Aden obtained data at 30,000 and 46,000 feet. At 30,000 feet the temperature and frost-point varied by only a few degrees over the 1100-mile track. Winds at this level were light southerly near Nairobi but somewhat stronger and easterly near Aden. Patches of turbulence were encountered near the base of the high cloud. (A useful subjective scale of turbulence is given in *Handbook of Weather Messages, Part II.*[2]) There was no cumulonimbus cloud over the route but high-cloud amounts were considerable though mainly in two layers, one just above 30,000 and a second more extensively between 40,000 and 45,000 feet. In the north there also appeared to be thin cloud well above 48,000 feet. At 46,000 feet the variability of the temperature and frost point was less than at the lower level. The winds were very strong easterly throughout, and considerable clear-air turbulence just above the cirrus tops was encountered during the southern half of the flight at this level.

Many of the main features of this flight were reproduced in the similar types of traverses made on 24, 25 and 27 June 1958 although it can be seen that there were significant differences in the cloud structures and minor changes in the wind field. At 30,000 feet, a level flown on each occasion, the temperatures varied little either from day to day or with latitude. The frost point was more variable as the base of the lowest high cloud was usually around this level. The wind was always moderate easterly at Aden but was more variable near Nairobi often with a southerly component. The steady increase of wind with height to strong easterly above about 40,000 feet is evident in each case although the details vary from day to day. At 38,000 feet on 24 June 1958, for instance, it was stronger at Nairobi than at Aden. The turbulence encountered was usually

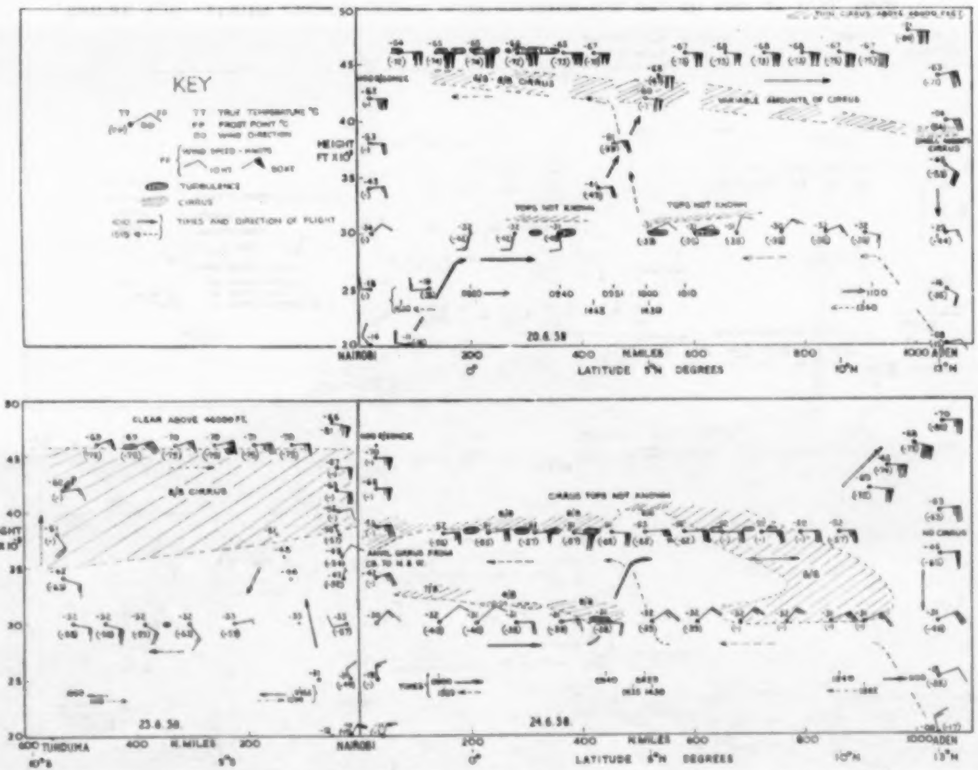


FIGURE 4(*a*)—FLIGHT CROSS-SECTIONS, ADEN–NAIROBI–9°S, 20, 23 AND 24 JUNE 1958

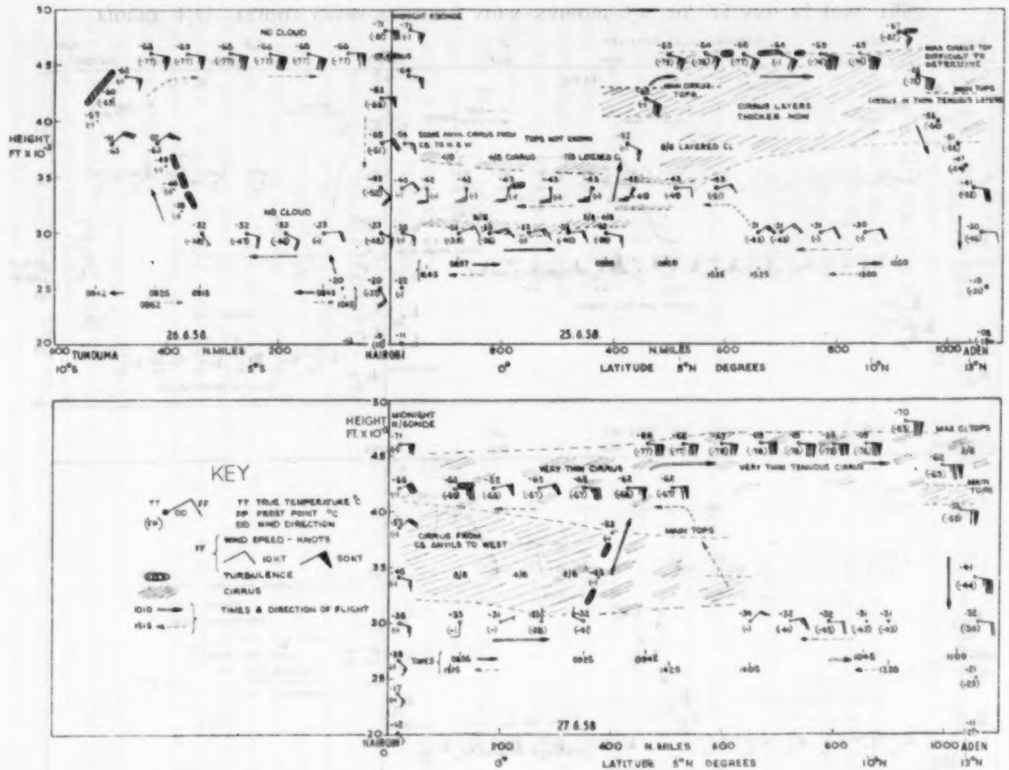
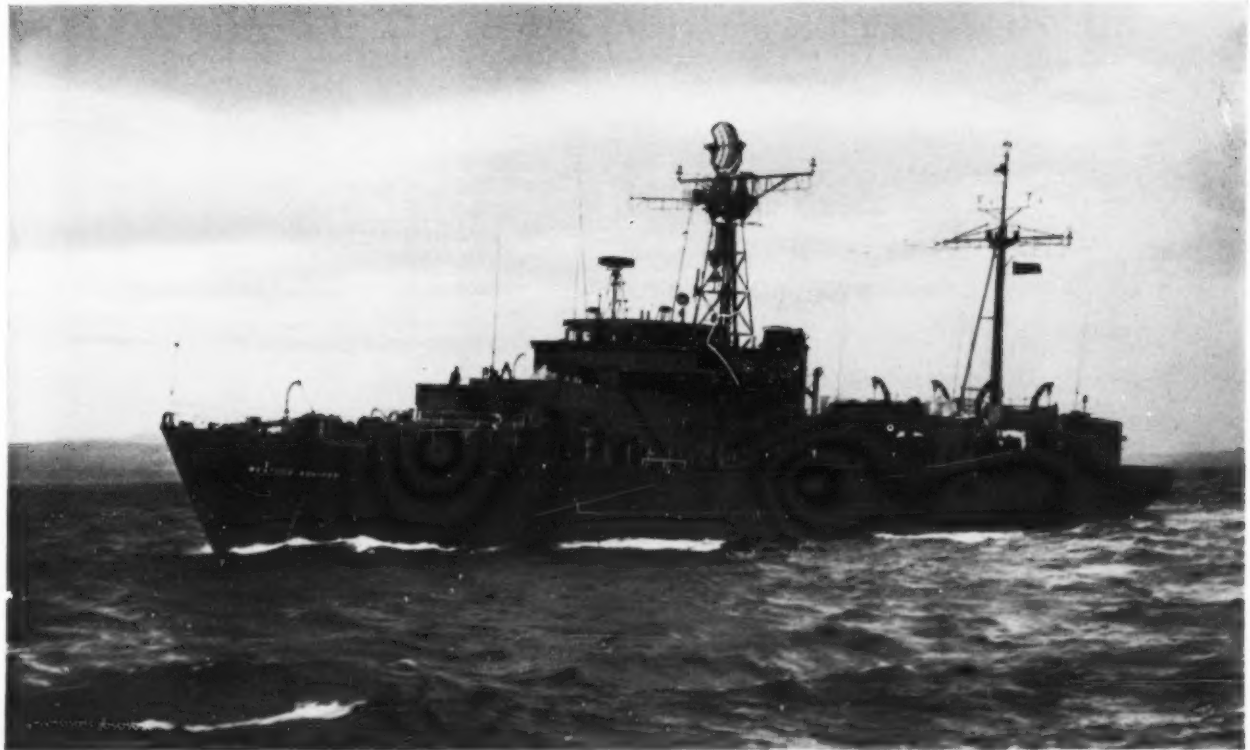


FIGURE 4(*b*)—FLIGHT CROSS-SECTIONS, ADEN–NAIROBI–9°S, 25, 26 AND 27 JUNE 1958

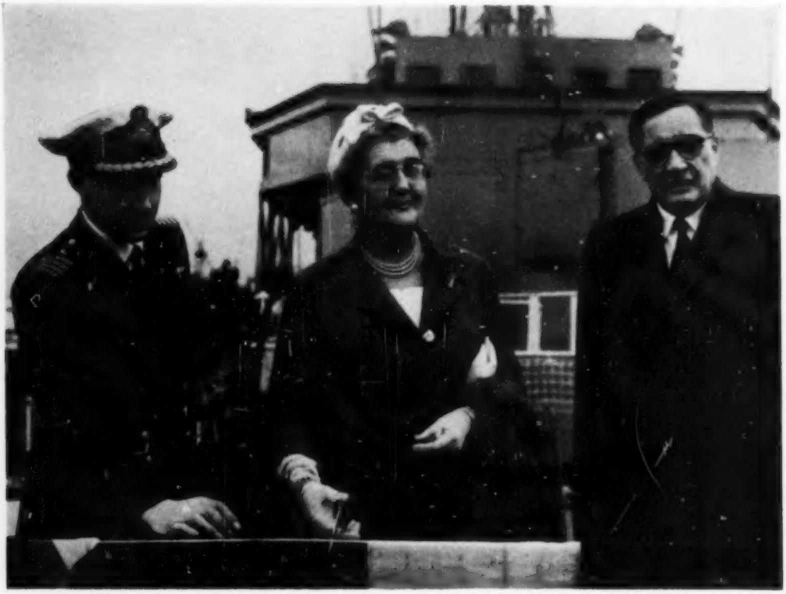
[To face p. 16



Reproduced by courtesy of James Hall Ltd.

"WEATHER ADVISER" AT SEA

(See p. 23)



Reproduced by courtesy of George Outram & Co. Ltd.

LADY SUTTON RENAMING "WEATHER ADVISER"

(See p. 23)

Reproduced by courtesy of James Hall Ltd.

MR. M. V. DUNPHY SHOWING A RADAR REFLECTOR TO LADY SUTTON

(See p. 23)

To face p. 17]

Reproduced by courtesy of George Outram & Co. Ltd.

INSPECTING THE SHIP'S COMPANY

(See p. 23)

associated with cirrus cloud in the lower flight levels and the region of strong winds at the higher levels. In the main it was much more frequent than would normally be expected at these levels in similar flights in temperate latitudes. The high-cloud systems shown were very extensive and on these other flights cumulonimbus clouds were observed and large areas of the high cloud, particularly at the lower levels and to the south, appeared to originate from the anvils of these clouds. The thinner, higher cirrus above 40,000 feet did not, however, appear to be associated with the cumulonimbus clouds.

The two flights to 9°S showed no large changes of wind and temperature fields from those measured at Nairobi. Winds at 30,000 feet were light easterly and increased to strong easterly towards 45,000 feet. It thus appears that over the period of these flights a steady strong belt of easterly winds existed in the middle and upper troposphere from at least 11°N to 9°S that is, over a distance of 1500 to 2000 miles. On the second flight (26 June 1958), when no high cloud was observed between 0° and 9°S, considerable clear-air turbulence was encountered in the ascent at 9°S from 30,000 to 46,000 feet—a region of considerable though not unusual vertical wind-shear. In contrast with this flight, that of 23 June 1958 was notable for a very extensive cirrus layer extending all over the flight region and between about 35,000 and 45,000 feet. This layer did not appear to be directly connected with any cumulonimbus activity.

The albedo observations are summarized in Figure 5.

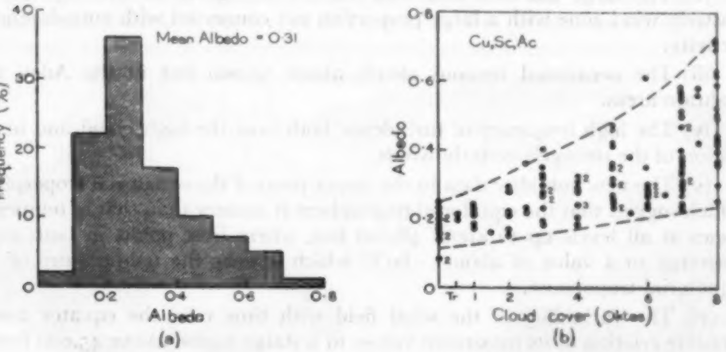


FIGURE 5—ALBEDO MEASUREMENTS, ADEN–NAIROBI–9°S

(*a*) This is a summary of all albedo observations obtained between Aden and 9°S presented as a frequency diagram.

(*b*) This is an attempt to correlate albedo with observed cloud amounts over the same route. Cloud amounts reported as n to $n+x$ oktas have been entered as $n+x/2$ oktas; a trace of cloud has been entered as ½ okta.

All the observed cloud was reported as cumulus, stratocumulus or altocumulus and has been lumped together for the correlation of cloud cover with albedo. It is believed that most of the cloud reported as cumulus or stratocumulus was in fact in medium levels, particularly over high ground (for example, Kenya), since cloud appears to retain its low-level physical characteristics to a much greater height than in temperate latitudes. The spread of observations in Figure 5(*b*) is due to the dependence of cloud albedo on thickness as well as amount. One feature of interest was the occasional reports of

very thin (100–300 feet thick) stratocumulus in apparently stable and sometimes unbroken layers. These layers are responsible for values of albedo of less than 0·3 reported for cloud amounts of 6–8 oktas.

It was practically never possible to climb above the cirrus that frequently covered the equatorial skies, although the aircraft was often in cirrus. For this reason, the planetary albedo of the Aden–Nairobi–9°S strip is probably at least 50 per cent higher than the mean value of 0·31 observed. Values of albedo reported in cirrus have reached 0·75–0·8 (probably in anvil cirrus) but are generally in the range 0·3–0·5. It was noted that the ground ceased to be visible for albedos of about 0·4.

Use was made of the observed downward flux of solar radiation as a function of time during the flights to assist in the detection of very thin cirrus above the aircraft.

Summary and conclusion.—The principal interesting information obtained on this series of flights is summarized below. Clearly these conclusions cannot be regarded as general without considerably more data but they illustrate several features worthy of further study:

(i) The strength, relative constancy and large horizontal extent of the easterly wind belt in the upper troposphere between about 25°N and 10°S at least in this region in summer.

(ii) The large amounts and wide extents of high-cloud coverage in this easterly wind zone with a large proportion not connected with cumulonimbus activity.

(iii) The occasional tenuous clouds above 50,000 feet in the Aden and Bahrain areas.

(iv) The high frequency of turbulence both near the high cloud and in the region of the strongest easterly winds.

(v) The new humidity data in the upper parts of the equatorial troposphere which suggest that the equatorial troposphere is moister than that of temperate zones at all levels up to about 48,000 feet, where frost points in both zones converge to a value of about −80°C which is near the temperature of the equatorial tropopause.

(vi) The variability of the wind field with time over the equator and a possible relation of its maximum values to a stable region above 45,000 feet in the equatorial troposphere.

(vii) The variability of the measured albedo with surface and cloud conditions.

Acknowledgements.—The author wishes to make acknowledgements to the R.A.F. aircrew, Flt. Lt. S. J. Thomas and Sqn. Ldr. J. Canning who conducted the flights; the Director and staff of the East African Meteorological Service who supplied much of the African synoptic data presented and gave every help while the aircraft was at Nairobi; Dr. R. J. Murgatroyd, who also arranged the detachment, for constructive criticism; and Mr. M. Jackson for assisting in the reduction of data.

REFERENCES

1. MURGATROYD, R. J.; Meteorological measurements in jet aircraft. *Shell Aviation News, London*, No. 244, October 1958, p. 7.
2. London, Meteorological Office; Handbook of weather messages, Part II, codes and specifications, London, 3rd edn., 1959, pp. 84, 98.

551. 591. 2(423)

DIURNAL VARIATION OF VISIBILITY WITH LIGHT WINDS AT PLYMOUTH IN WINTER

By W. E. SAUNDERS, B.Sc.

The effects of smoke on the diurnal variation of fog at airfields near large towns have received attention in a number of papers in recent years. It has been shown that heavy concentrations of smoke change the time of maximum fog frequency from the period around sunrise (which applies to rural sites) to some two hours later. Less attention has been given to visibility near the centres of large towns, mainly because the observing stations are mostly located at aerodromes on the outskirts. Visibility changes within the built-up areas are, however, of increasing importance to aviation, owing to the use of helicopters.

This note deals with winter visibilities at Plymouth (Mount Batten). An analysis of the cloud height and visibility at this station was undertaken by Walters in 1942.[1] This was based on pre-war data (for the five years 1933–37), and only on five observations per day. The variation of mist and fog with wind direction, and with the season of the year, was described. It was shown that while, in summer, most of the mist and fog reported is with south to south-south-west winds, in winter it occurs with more variable winds, mainly between north-west and north-east. The summer fogs are mainly sea fogs, brought in by moist winds from the Atlantic. These are air mass features, with little if any diurnal variation. The winter mists and fogs are partly due to radiation, but probably mainly due to the smoke of Plymouth. The present note deals with the diurnal variation of visibility during periods of light winds in the winter.

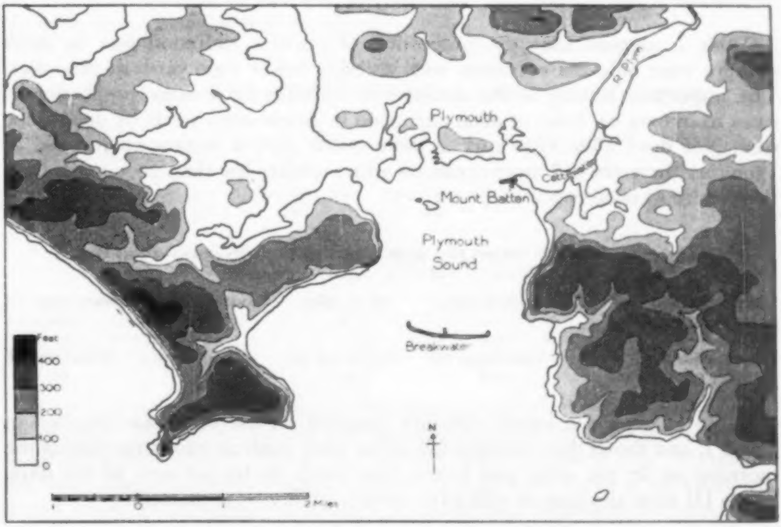


FIGURE 1—PLYMOUTH SOUND AND SURROUNDING AREA

The general topography of the area is shown in Figure 1. It may be added here that the visibility observations take in the lower parts of the city of Plymouth, and the Cattewater (a narrow strip of water separating Mount Batten

from Plymouth). The observations do not refer to Plymouth Airport, which is at Roborough, some four miles north of the city.

The analysis is confined to the winter months December, January and February, for the five years up to February 1960. Since the main interest is in daytime helicopter flights, and since smoke effects are seldom serious with winds over 10 knots, the investigation has been confined to days on which during the morning period, taken as 0600–1300 GMT, the wind speed did not exceed 10 knots. The period 1400–2100 GMT has been dealt with separately on a similar basis.

During the five winters there were 116 mornings on which the wind did not exceed 10 knots. The frequencies of various ranges of visibility are given in Table I.

TABLE I—VARIATION OF VISIBILITY DURING WINTER MORNINGS WITH LIGHT WIND AT MOUNT BATTEN

Visibility range	Time, GMT 0600	0700	0800	0900	1000	1100	1200	1300
	number of occasions							
Over 6 miles ...	17	15	6	4	2	6	10	19
2½–6 miles	45	43	29	12	16	18	33	42
3000–4200 yd ...	16	17	15	14	5	9	8	9
2000–2990 yd ...	21	16	19	19	23	19	20	15
1500–1990 yd ...	4	4	5	14	13	11	13	8
1000–1490 yd ...	3	10	26	28	33	28	14	11
500–990 yd ...	1	3	7	16	14	19	14	10
Below 500 yd ...	9	8	9	9	10	6	4	2

Table I suggests that the proportion of genuine radiation fogs is small —there were only ten occasions with visibility below 1000 yards at 0600 GMT. The important feature is the decrease in visibility in a large proportion of cases from over 2½ miles at 0600 and 0700 to below 2000 yards by 0900–1000 GMT. Not until after 1100 GMT is there much sign of improvement, and at 1300 GMT there are still more occasions with visibility less than 2000 yards than there were at 0600 GMT.

TABLE II—LOWEST VISIBILITY REPORTED IN PERIOD 0600–1300 GMT

Lowest visibility ...	over 6 miles	2½–6 miles	3000–4200 yd	2000–2990 yd
Number of occasions ...	—	6	9	16
Lowest visibility ...	1500–1990 yd	1000–1490 yd	500–990 yd	below 500 yd
Number of occasions ...	12	25	29	19

Table II gives the lowest visibility reported on the occasions included in Table I, and shows that visibility fell below 3000 yards at some time during the morning on 87 per cent, and below 1500 yards on 63 per cent of the days. Table III gives the time at which the worst visibility was reported.

TABLE III—TIME AT WHICH LOWEST VISIBILITY OCCURRED

Time, GMT, at which lowest visibility reported	0600	0700	0800	0900	1000	1100	1200	1300
Number of occasions ...	6	9	19	29	27	11	9	6

Table III shows that the worst visibility is often not reached until 0900–1000 GMT. Also, the lowest visibility during the morning period is as likely to be at 1200–1300 as it is at 0600–0700 GMT.

The afternoon and evening period, taken as 1400–2100 GMT, was similarly examined. There were 114 light wind occasions, and the visibility frequencies are given in Table IV.

TABLE IV—VARIATION OF VISIBILITY DURING WINTER AFTERNOONS AND EVENINGS WITH LIGHT WINDS AT MOUNT BATTEN

Visibility range	Time, GMT 1400	1500	1600	1700	1800	1900	2000	2100
	number of occasions							
Over 6 miles ...	25	20	14	3	1	1	1	4
2½–6 miles ...	48	47	41	20	14	14	17	16
3000–4200 yd ...	14	15	16	18	19	22	14	19
2000–2990 yd ...	11	17	23	40	50	45	48	43
1500–1990 yd ...	2	3	6	10	13	10	12	6
1000–1490 yd ...	7	6	7	16	9	13	13	17
500–990 yd ...	5	4	6	5	4	6	6	4
Below 500 yd ...	2	2	1	2	4	3	3	5

The main feature in Table IV is the visibility deterioration in the dusk period. The changes are less sharply pronounced than in the morning, and the most frequent deterioration is into the 2000–3000-yard range.

Tables V and VI give the lowest visibility reached in the afternoon and evening, and the time at which it was reached. The dusk period is seen to be the most likely time for deterioration.

TABLE V—LOWEST VISIBILITY REPORTED IN PERIOD 1400–2100 GMT

Lowest visibility ...	over 6 miles	2½–6 miles	3000–4200 yd	2000–2990 yd
Number of occasions ...	—	3	9	43
Lowest visibility ...	1500–1990 yd	1000–1490 yd	500–990 yd	below 500 yd
Number of occasions ...	10	29	10	10

TABLE VI—TIME AT WHICH LOWEST VISIBILITY OCCURRED

Time, GMT, at which lowest visibility reported	1400	1500	1600	1700	1800	1900	2000	2100
Number of occasions ...	5	10	7	26	22	13	9	22

It may be noted that the results presented do not give the full picture as to the number of days during the five winters on which visibility deteriorations occurred, since occasions on which the wind speed increased over 10 knots at any time were omitted in order to obtain a comparable series of observations. There were, for example, a number of additional mornings on which the visibility deteriorated along the lines suggested by Table I, but which were omitted because the wind speed later exceeded 10 knots. The wind speeds and corresponding visibilities for the morning of 29 December 1958 (Table VII) show how even a temporary lull in the wind during the critical smoke period produces a sharp visibility deterioration.

TABLE VII—WIND SPEED AND VISIBILITY, 29 DECEMBER 1958

Time, GMT	Wind speed, kt	Visibility
0600	11	10 miles
0700	3	10 miles
0800	2	2000 yards
0900	12	6 miles
1000	15	8 miles

It is also pointed out that the investigation was restricted to the midwinter months of December to February, but that similar deteriorations occur in November and March, and more exceptionally in October and April.

There can be no doubt that the visibility deteriorations are due to the smoke, partly domestic and partly industrial, from Plymouth and the growing dormitory areas, such as Plymstock. The morning deteriorations, in particular, are probably mainly due to smoke from industrial sites near the River Plym. When the pressure gradient over south-west England is light, and there has been a radiation night, there is a slow drift from the north-east of cold air from Dartmoor. This carries smoke from the Plym area to the Cattewater and the inshore part of Plymouth Sound where, having found its lowest level, it remains until there is some freshening of the wind. With the tendency for industrial development to increase in the area surrounding the Plym there seems little prospect of the winter visibility problem near Mount Batten improving.

REFERENCE

1. WALTERS, A.; An analysis of cloud height and visibility at Mount Batten. *Aviat. met. Rep., London*, No. 14, 1942.

551·577·3

YEAR-TO-YEAR VARIATIONS IN RAINFALL TOTALS

By L. P. SMITH, B.A.

Summary.—For practical purposes, the variations in rainfall can be conveniently represented by ten sample percentages of average. Such samples vary with the length of period considered, but the percentages are reasonably constant over England and Wales, both in high or low rainfall areas.

Introduction.—For irrigation planning it is necessary to find a method of representing the rainfall climate which gives not only the average value but also the expected variations about the average. The simplest way of doing this has been found to be the calculation of ten percentages which, when multiplied by the appropriate average, give ten sample rainfalls. These would give an estimate of the rainfall totals over ten years arranged in ascending, but not chronological order.

Suppose, for example, it was required to find the frequency and extent of irrigation need on a given farm. The optimum conditions might demand the maintenance of field capacity during May and June. The average rainfall and potential transpiration for the area are found. The ten sample percentages for a two-month period are then multiplied by the average rainfall to give ten sample totals which are assumed to represent the rainfall of the next decade. The transpiration is assumed to be constant, an assumption which is reasonable because variations from average are relatively small. By simple subtraction of the rainfall samples from the potential transpiration, not only is the frequency

of need (in years out of ten) found, but also a working estimate of the amount of extra water required. With these details the irrigation potential can be estimated in regard to both productivity and cost of installation, quite apart from the essential basic problem as to whether sufficient water is available to meet the irrigation need.

Previous work.—Several years ago such samples were calculated by examining the rainfall totals for 60 stations over the 25 years 1924–48. These stations were selected from five main areas, namely, Kent, the Vale of Evesham, Somerset, the Fen district and south Yorkshire. Only the summer months, April to September, were analysed and mean sample percentages were calculated for periods of 1, 2, 3, 4, 5, and 6 months. These samples were published in the Ministry of Agriculture's Technical Bulletin No. 4.[1]

Present investigation.—Because the previous work was based on observations in a restricted area, over a short period of years and from stations with low rainfall averages, a new investigation was started using twelve well scattered stations with 50-year (1910–59) records. These are shown in Table I.

TABLE I—STATIONS UNDER REVIEW

Station	Northern Area 1916–50 annual average in.	Station	Southern Area 1916–50 annual average in.
	Low Rainfall		
Newcastle	28	Oxford	26
Lincoln	24	Thetford (Norfolk) ...	25
Shrewsbury	26	Ashford (Kent) ...	29
	High Rainfall		
Carlisle	32	Treherbert (Glam) ...	94
Haslingden (Lancs) ...	57	Kennick (Devon) ...	44
Leyburn (Yorks) ...	35	Ringwood (Hants) ...	33

Method of analysis.—For each station the six-month (April to September) rainfall total for each of the 50 years was expressed as a percentage of the 50-year mean. The required ten samples were then calculated by taking the mean of the five lowest percentages, the mean of the next lowest, and so on. The final figures were meaned over the twelve stations for each of the ten samples; similar means were also found for the six northern and six southern stations, and also for the six high rainfall and the six low rainfall stations.

This was repeated for 5, 4, 3, 2 and 1 month periods, using each possible combination of successive months during the summer period. The winter six-month samples (October to March) were also calculated.

Results.—The results for the twelve stations taken together were very similar to those previously published. The only difference worthy of comment was for the driest year in ten, when the previous work suggested a slightly lower percentage than the present investigation. The difference was hardly significant statistically and the published figures would not have occasioned any major errors.

Comparison between high and low rainfall areas showed little difference indeed, but there was a distinct tendency for the southern area stations to experience relatively drier years than those in the north. There is also a tendency, which is apparent in all areas, for lower rainfall totals during the later months in the summer period. (See Table II.)

TABLE II—LOWEST SAMPLE PERCENTAGE FOR A TWO-MONTH PERIOD

Months	Northern Area	Southern Area
	%	%
April and May	50	46
May and June	48½	44½
June and July	44	37
July and August	40½	35
August and September ...	36	35

The results may be summarized as in Table III. The full details have been circulated in Meteorological Office Agricultural Memorandum No. XXXI.[2]

TABLE III—SAMPLE PERCENTAGES OF RAINFALL AVERAGES

Northern Area

Period	Lowest in 50 years	Samples 1	2	3	4	5	6	7	8	9	10
Summer							*per cent*				
6 months	53	62½	74½	83½	91	97	101½	107½	115	123½	144
5 months	51	61	73	81	89	96	103	108½	116	126½	146
4 months	49	58½	71	79½	87½	94½	102	108	116½	130	152½
3 months	44	53	67	77	86	94	102	110	119	133	159
2 months	30½	44	61½	72½	82	92	101	112½	123	139½	172
1 month	11	24½	47	62	75	87	99	113½	131½	155½	205
Winter											
6 months	58	65	76	83½	90½	95	101	108	115½	123	142½

Southern Area

Period	Lowest in 50 years	Samples 1	2	3	4	5	6	7	8	9	10
Summer							*per cent*				
6 months	48	58½	72½	82½	90	96	103½	109½	116	127½	144
5 months	46	57½	71½	82	89	96	102½	109	117½	127½	147½
4 months	42½	54	69½	79	87	94½	102	110	120	131	153
3 months	38	49	66	76½	85	94	102	111½	121	135½	159½
2 months	27	39½	58	70½	81½	92½	103	113½	125½	142	174
1 month	9	20½	42½	59	73½	87	101	116½	134½	159	206½
Winter											
6 months	55	62½	75½	84	92	96½	101½	107½	115	124½	141

REFERENCES

1. Ministry of Agriculture and Fisheries; The calculation of irrigation need. *Ministr. Agric. and Fish. Tech. Bull., London,* No. 4, 1954, Table 8.
2. SMITH, L. P.; Year-to-year variations in rainfall totals. *Met. Off. agric. Memor., London,* No. XXXI, 1960 (unpublished, available in Met. Office Library).

"WEATHER ADVISER"

By C. E. N. FRANKCOM, O.B.E.

On 22 September, at the James Watt Dock in Greenock, the "Castle" class frigate *Amberley Castle*, having been converted to an ocean weather ship, was renamed *Weather Adviser* by Lady Sutton, wife of the Director-General of the Meteorological Office. The extensive work of converting her for her new duties had been carried out by the Blyth Dry Dock and Shipbuilding Co. Ltd. (Northumberland); a job which took about nine months to complete.

Lady Sutton was accompanied by her husband; the guests attending the ceremony included the Provost of Greenock, representatives of the shipyard, local authorities, and wives of various members of the ship's company. Appropriately enough, it was a fine sunny day, so that the River Clyde looked at its best; *Weather Adviser*, with her newly painted yellow upper works and blue hull

and "dressed" with the flags of all those countries which operate weather ships in the North Atlantic, looked quite colourful. Her sister ship *Weather Reporter* and the veteran *Weather Observer*, the latter now withdrawn from active service and looking rather forlorn, were berthed astern of her. *Weather Adviser* ship's company were drawn up on the quay alongside the ship.

Before the actual renaming, Sir Graham Sutton gave an informal talk to the ship's company and guests in which he paid tribute to the good job that the ocean weather ships have done during their thirteen years of international duty in the North Atlantic. He emphasized the value of the surface and upper air observations made aboard these ships, not only for aviation but for general meteorological purposes and said how much he appreciated the way in which all concerned had continued to carry out this important work under the arduous conditions of North Atlantic weather. After inspecting the ship's company, Sir Graham and Lady Sutton accompanied by the Captain went aboard the ship where Lady Sutton cut a tape to release a canvas cover disclosing the ship's name, saying "I rename this ship *Weather Adviser*, may God bless her and all who sail aboard her". The visitors were then invited aboard the ship to inspect her and to take tea. The lay-out of *Weather Adviser* is very similar to that of *Weather Reporter*, but certain improvements have been introduced as a result of experience gained with *Reporter*. The arrangement of the accommodation has been improved by narrowing the alleyways and thereby giving somewhat larger cabins, and the meteorological office, radio receiving room, radar office and chart room have all been increased appreciably in size. The lay-out of the meteorological office is somewhat better than that aboard *Reporter*, and provision is made for the installation of "Cintel" equipment for automatic radio-sonde reception when that becomes available. The radio equipment of *Adviser* is of a commercial design and considerably more modern than that which was available for installing aboard *Reporter*. The naval type stabilized ten-centimetre radar equipment for radar-wind finding and for providing navigational "fixes" to aircraft in flight is similar to that carried in the other British weather ships, but is of more modern design. In order to achieve better results when the wind-finding balloon is abaft the ship during a radar-wind ascent, the fore-top mast has been removed. As in *Weather Reporter*, the lining and deck heads of all accommodation and offices are covered with plastic leather cloth bonded to asbestos panels, and the decks are covered with resin-bound tiles. All Officers and Petty Officers are berthed in single cabins; the ratings are berthed three in a cabin. Generally the accommodation is as good as one would find in any modern ship of a similar size, and the appearance of the furniture is particularly attractive.

In command of *Weather Adviser* is Commander H. Sobey, R.N.R., who joined *Weather Watcher* as Chief Officer in 1947 and was promoted to Command of *Weather Observer* in 1952. Unfortunately he fell sick shortly before the ceremony and Captain J. Clark, who would normally have been Chief Officer, assumed temporary command of the ship. Two other members of her ship's company have served in the weather ships since 1947; Mr. Lambert, the radio overseer and Mr. Gilbey, the boatswain, while two others have served in the ships since 1948. Mr. Dunphy, one of the meteorological officers, has the distinction of being the longest serving meteorologist in British ocean weather ships; he joined them in 1949 and has done 75 voyages. It was a coincidence that on the day of the renaming ceremony Mr. Dunphy received the news that he had been

awarded the L. G. Groves Second Memorial Award. Mr. Jones, the meteorological officer-in-charge aboard the ship has been in the weather ships since 1953.

Weather Adviser replaces *Weather Observer*, which was the first British weather ship to take up duty at a North Atlantic station in August 1947. *Weather Observer* did a consistently good job during her 103 voyages as a weather ship and fully maintained the reputation of the "Flower" class corvettes for sea-keeping qualities.

Two other "Castle" class frigates are being converted to ocean weather ships at Blyth, and are expected to be in service during 1961, in replacement of *Weather Recorder* and *Weather Watcher*.

NOTES AND NEWS

Universal Decimal Classification

551.5 *Meteorology*

In an earlier issue[1] were described the major changes, effective from 1 January 1957, from the classification in force since 1 January 1950. At its second session in November 1957 the former Commission for Bibliography and Publications of the World Meteorological Organization again agreed on a number of revisions of 551.5 which were later agreed by the Executive Committee and the International Federation for Documentation.

The complete revised classification was published as an appendix[2] to *WMO Technical Regulations* Volume 1, 2nd Edition, and was, at short notice, brought into use in the Meteorological Office Library for classifying books and papers received on and after 1 July 1960.

The major changes from the classification in force since 1 January 1957 are as follows:

551.501.7 *Upper air, methods of observation and computation.* Nine subdivisional numbers are allocated to cater for separate elements.

551.507.362.1 *Rockets* and 551.507.362.2 *Artificial satellites.* New numbers under 551.507.3 *Sounding vehicles for upper air, meteorological uses.*

551.508.86 *Sferics equipment.* New number added under 551.508.8 *Combined instruments.*

551.509.324 *Precipitation, rime, glazed frost* changed to *Cloud, precipitation, rime, glazed frost* under 551.509.3 *Bases and methods of forecasting.* Three appropriate subdivisional numbers are added.

551.509.33 *Forecasts for long period (week, month or season).* Eight subdivisional numbers are allocated to cater for the varying forecasting methods such as correlation in space or time, analogue methods etc.

551.509.54 *Precipitation, glazed ice, rime,* changed to *Cloud, precipitation, rime, glazed frost* under 551.509.5 *Organization of forecasting services, use and checking of forecasts.* Three appropriate subdivisional numbers are added. See 551.509.324 above and remarks.

551.509.61, 551.509.612, 551.509.615, 551.509.617 are replacement numbers under 551.509.6 *Deliberate action on the weather* as distinct from 551.509.68 (new number) *Accidental action on the weather.*

551.510.535.2 and 551.510.535.4 are new numbers under 551.510.535 *Ionosphere*.

551.510.61, 551.510.62, 551.510.7, 551.510.71, 551.510.72, 551.510.721 are new or replacement numbers the first two of which cater for *Optical and radio refractive indices* and the remainder for *Atmospheric radioactivity and radioactive fall-out*.

551.515.4 *Thunderstorms* changed to *Convective precipitation systems, thunderstorms and showers*.

551.515.5 *Tropical atmospheric formations and disturbances other than tropical cyclones, hurricanes, typhoons*. New number with four appropriate subdivisional numbers.

551.515.9 *Damage caused by weather in general*. New number.

551.521.17 *Ultra-violet radiation* and 551.521.18 *Infra-red component of solar radiation*. Replacement numbers under 551.521.1 *Solar radiation in general* instead of under 551.521.6 *Radiation of specific wavelengths and corpuscular radiation* which number now becomes *Cosmic and corpuscular radiation*.

551.524.372 *Damage caused by frost*. New number.

551.524.7 *Upper air temperatures*. Ten subdivisional numbers are added to conform with the breakdown of surface air temperature.

551.574.1 *Physics, nuclei* becomes *Physics of condensation*. Four appropriate subdivisional numbers are added.

551.577.13 *Chemical properties* and 551.577.7 *Radioactivity of precipitation*. New numbers in *Precipitation* section.

551.578.46 *Snow cover* is given seven appropriate subdivisional numbers.

551.578.48 *Avalanches*. New number with four appropriate subdivisions.

551.590.3 *Effects of volcanic eruptions on weather and climate*. New number.

551.594.25 *Electricity of precipitation* becomes *Electricity of aerosols* with four appropriate subdivisions.

This note is published with the agreement of the British Standards Institution, copyright holders of the Universal Decimal Classification in the United Kingdom. The relevant BSI publications are quoted. [3,4]

REFERENCES

1. London, Meteorological Office. Universal Decimal Classification 551.5 Meteorology. *Met. Mag., London*, **86**, 1957, p. 22.
2. Geneva, World Meteorological Organization. Technical Regulations, Volume 1—General, 2nd Ed., Appendix G., WMO—No. 49 Bd. 2/3, Geneva, 1959.
3. London, British Standards Institution. Universal Decimal Classification, English edition. British Standard 1000, 2, Part 3, Geology and geophysics (including meteorology), London, 1943.
4. London, British Standards Institution. Universal Decimal Classification, abridged English edition. British Standard 1000A, 2nd Ed. revised, London, 1957.
5. The Hague, International Federation for Documentation. Extensions and corrections to the UDC. The Hague, issued half-yearly.

Training courses for co-operating observers

Two courses for co-operating observers were held again this year at the Meteorological Office Training School, Stanmore. The first, intended primarily for agricultural meteorological station observers, was held from 3–7 October and the second, designed for climatological and health resort station observers, from 10–14 October 1960. The courses consisted of instructions in instrument maintenance, the taking and recording of weather observations, the completion of returns and, for the agricultural meteorological observers, talks on agricultural meteorology. In addition films and slides were shown and there were discussions on the applications of climatological data.

The agricultural meteorological station observers were taken on a visit to the Rothamstead Experimental Station by kind permission of the Director, and a visit to the London Weather Centre was arranged for the climatological station observers. Finally, both courses visited Harrow where they were able to see the British climatology branch, the punched-card installation, the instrument test rooms and wind tunnel, and where there were opportunities for discussing any problems at their particular stations.

In all, 42 observers attended the courses. They included agricultural students, foresters, school teachers, borough engineers and surveyors, etc., their ages ranging from 18 to 65. All were enthusiastic and the courses appeared to be much appreciated, particularly the periods devoted to practical work.

OFFICIAL PUBLICATIONS

The following publications have recently been issued:

Handbook of aviation meteorology.

The primary object of this handbook is to provide a work suitable for the use of pilots and navigators undergoing intermediate or advanced courses of instruction at flying training schools, whether military or civilian. Within these limits the subject is covered comprehensively, but an elementary knowledge of meteorology on the part of the reader will be an advantage. The presentation has been made reasonably simple and physical ideas explained as they arise; mathematical knowledge is not required beyond an ability to handle some simple formulae, but for the benefit of readers familiar with elementary calculus, proofs of most of the formulae used are collected together in an appendix.

It is, however, neither possible nor desirable to confine the scope of such a book to the precise needs of students attending a variety of courses and requiring to pass one or other of the several examinations open to them. Accordingly, with but very little widening of the scope, the book has a secondary object, that of the presentation of a general account of meteorology, including its theory and practice and its applications to aviation. It is hoped, therefore, that it will be found useful to any who are in one way or another concerned with the applications of meteorology to aviation and who require a non-mathematical account of the subject.

The book is divided into five parts which are more or less independent. Part I contains a somewhat detailed account of the physical principles of the subject, together with their immediate applications to aviation. Part II gives a brief description of the raw material of meteorology—the observations, how they are

made, distributed and charted. This leads on to a discussion of synoptic meteorology including examples of synoptic charts in Part III, with an outline of the principles of weather forecasting. Part IV describes the organization of the meteorological services for aviation; and finally Part V explains and describes very briefly the salient features of weather over the world and on the air routes.

The book, largely the work of Mr. A. F. Crossley of the Meteorological Office, was prepared as a successor to Dr. R. C. Sutcliffe's *Meteorology for aviators*.

GEOPHYSICAL MEMOIRS

No. 103—*Upper winds over the world; Parts I and II.*

This is a completely new edition of the earlier Memoir published in the same series and under the same title in 1950. A revised edition became both feasible and necessary because of the greatly extended geographical coverage of upper air data since the preparation of the earlier Memoir, which, moreover, has been out of print for several years.

The scope of the new edition is more comprehensive than that of any known similar publication. The information is presented mainly in the form of charts covering the whole world except for Antarctica. Average winds at six standard upper levels from 700 to 100 millibars (approximately 3,000 to 16,000 metres) are charted for the four mid-season months, January, April, July and October, the period covered being 1949–53. There are separate series of charts for contours of the standard constant-pressure surfaces and for the direct representation of the winds by average streamlines and isotachs. It is intended to show the variability of wind by charts of standard vector deviation, to be published separately as Part III.

Besides aiding studies of the general circulation of the atmosphere the Memoir provides information of practical use in aircraft design and air-route planning.

SCIENTIFIC PAPER

No. 4—Pressure variation over Malaya and the resonance theory. By R. Frost, B.A.

An analysis of the hourly observations from six Malayan stations near the equator shows the following features of the semi-diurnal variation of pressure:

(i) The amplitude of the second harmonic is greater near the thermal than the geographical equator.

(ii) The amplitude is greatest when the sun is overhead in March and September, and is greater in January when the sun is nearest to the earth than in July when the sun is farthest away from the earth.

(iii) The mean monthly values of the amplitude show a close relationship with the monthly totals of solar radiation at the equator.

(iv) The mean value of the phase angle of the second harmonic is in phase with the passage of the sun.

(v) The time of maximum phase angle of the second harmonic expressed in local time occurs earlier on the west coast than on the east coast, but a difference in geographical pattern in the time of maximum phase angle occurs between the north-east and south-west monsoon seasons.

The above features are difficult, if not impossible, to reconcile with any resonance theory and an alternative theory is suggested.

METEOROLOGICAL OFFICE NEWS

Retirement.—The Director-General records his appreciation of the services of:

Mr. W. J. Fowler, Senior Experimental Officer, who retired on 10 November 1960. He joined the Office in September 1915 as a Boy Clerk at Falmouth Observatory, which was then administered by the Meteorological Office. From May 1918 to December 1919 he served in the Meteorological Section of the Royal Engineers. On demobilization he returned to Falmouth Observatory, but after a few months he was transferred to an aviation outstation. In 1921 he was posted to an outstation associated with services for the Army where he remained for some ten years. In 1931 he was again transferred to an aviation outstation and his subsequent career was spent at a number of such outstations, including several overseas in Iraq, Italy, Austria, Germany and the West Indies. From 1954 until his retirement he served at Upavon. Mr. Fowler has accepted a temporary appointment in the Meteorological Office.

Move of Meteorological Office Library to the Meteorological Office Headquarters, Bracknell

The Library will be occupied with the move of its material and certain pre- and post-removal matters during the overall period 6 March–21 April 1961. During this time the normal outside loans and advisory services will be suspended though certain limited facilities will be available, internally, on a personal reference basis for an interval after 6 March at Harrow and before 21 April at Bracknell.

The new address, effective from 11 April 1961, will be:

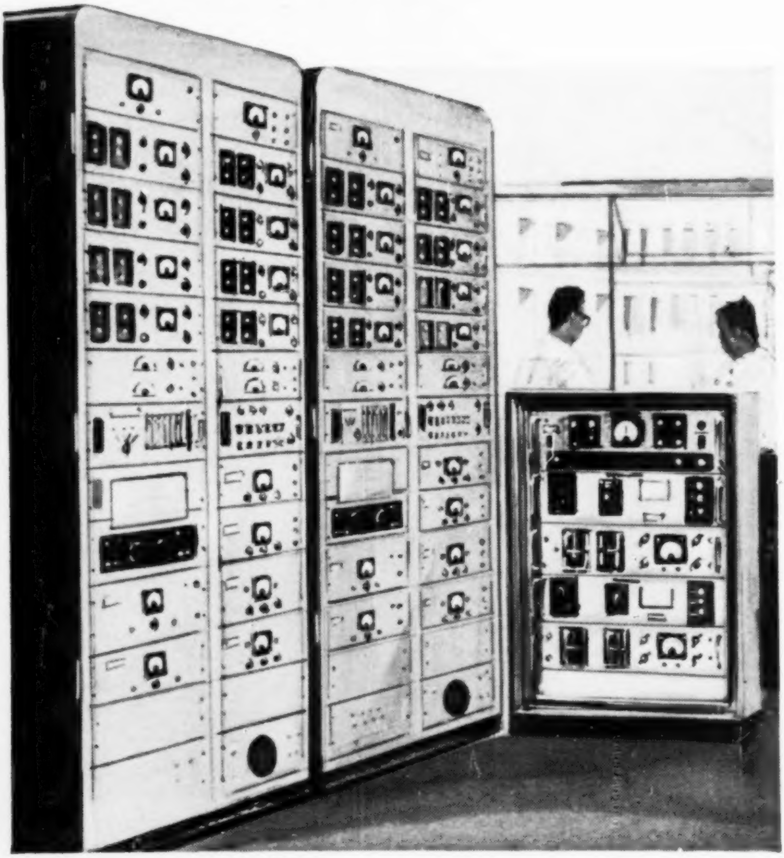
The Library,
Meteorological Office,
London Road,
Bracknell,
Berkshire.
Telephone: Bracknell 2420, Ext. 251

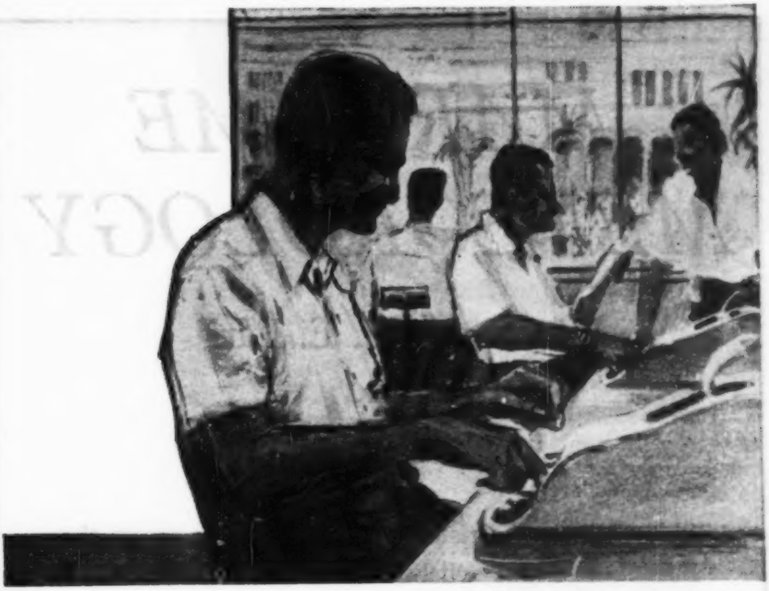
Plessey

TELECOMMUNICATIONS

speed weather forecasting

Plessey is everywhere, you'll find . . . in the Middle and Far East for example, where minute by minute plotting and data transmission are the only key to effective warning of adverse weather conditions.





The ubiquity of Plessey Radio Teleprinter Equipment is as complete in world meteorology, press and consular services, as Plessey Telecommunications is in the total telecommunications field. A vital amenity for any civilised community, the accurate dissemination of weather data is essential to airways, to planned agriculture, and in many localities to the very preservation of life itself. It is a field of service in which the Plessey Company is proud to be making a major contribution.

Behind this achievement are the extensive prototype and quality manufacturing resources of the Telecommunications Division, inspired by the work of a unique research and development organisation. The Company recognises the need to segregate advanced thinking from the hustle and distraction of the factory. Accordingly, in addition to the Group Research Laboratories at Roke Manor and other specialised research centres already existing in the U.K., extremely well equipped laboratories have recently been established at West Leigh for advanced telecommunications studies. In these establishments, the next generation of telecommunications equipment is already taking shape.

In close support at all times are the complete resources of the Plessey Group of Companies which include unrivalled tool making and machining facilities, a full range of environmental testing and production laboratories, and the services of the materials laboratories at Caswell.

TELECOMMUNICATIONS DIVISION · ELECTRONIC & EQUIPMENT GROUP

THE PLESSEY COMPANY LIMITED · ILFORD · ESSEX · Telephone: ILFORD 3040

Overseas Sales Organisation: Plessey International Limited · Ilford · Essex · England

TD4C

MARITIME METEOROLOGY

By Captain G. E. Earl
and
Captain N. L. Peter

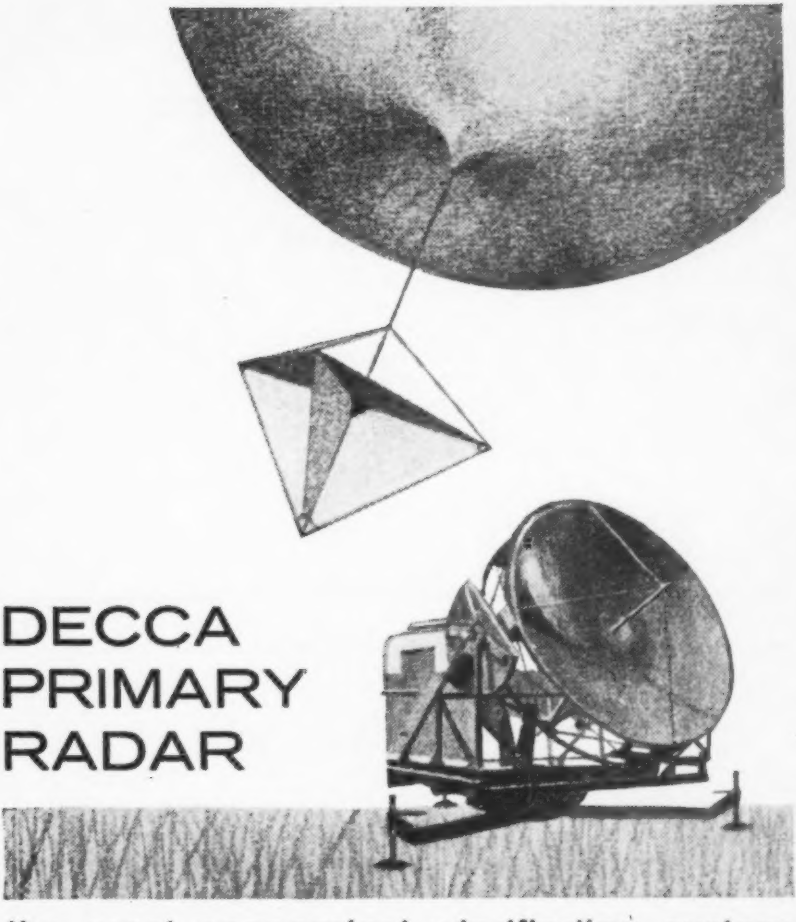
Ship-shape, and Bristol-fashion, this book covers the Board of Trade syllabus in a clear concise form specially devised for rapid reference and easy assimilation. Designed to meet the needs of mariners, it has special chapters on ocean currents, ice observation and patrol services, forecasting at sea, coding and decoding bulletins and on meteorological instruments used at sea. None the less, it is an excellent general introduction for all who wish to understand the basic principles of the subject.

128 pages 42 maps and diagrams $8\frac{1}{2}$ by $5\frac{1}{2}$ inches

PRICE 12/6

Maritime Press List available from:

THE MARITIME PRESS LTD.
32 Fleet Street, LONDON, E.C.4



the most economical windfinding system

An outstanding feature of the new Decca WF2 Windfinding Radar is its high performance coupled with low daily operating cost. A new high power transmitter increases the possible maximum slant range to some 200,000 metres, and enables a smaller and cheaper target to be used for shorter ranges. The equipment is so designed that it can be operated by one man and is capable of providing wind speed and direction up to an altitude of 100,000 feet in all parts of the world.

WF2—the most advanced windfinding radar in the world

DECCA RADAR

DECCA RADAR LIMITED · LONDON · ENGLAND

DRISI

ANGLIA TELEVISION LIMITED

—who are Contractors to the Independent Television Authority for East Anglia, are seeking the services of a fully qualified

METEOROLOGIST

The successful applicant will be required to collaborate with the Meteorological Office in the daily preparation of weather reports and detailed regional forecasts and personally to present these to television viewers.

The position will be permanent and pensionable, and applications should be addressed, marked confidential, to:

The Secretary, Anglia Television Limited, Anglia House, Norwich, Norfolk, NOR 07A

METEOROLOGIST

required by the Government of Mauritius, on contract for one tour of three years in first instance.

Salary, according to experience, up to £1,665 a year. Gratuity at rate of £150/200 a year. Free passages. Liberal leave on full salary.

Candidates should have at least five years experience of independent forecasting for aviation at an aerodrome forecast office in an official Meteorological Service.

Apply to CROWN AGENTS, 4 Millbank, London, S.W.1 for application form and further particulars, stating age, name, brief details of qualifications and experience and quoting reference M3C/53259/M1.